भारतीय मानक
Indian Standard

IS 397 (Part 0) : 2021

उत्पादन के दौरान सांख्यिकीय गुणता नियंत्रण की प्रणाली

भाग 0 नियंत्रण चार्ट के चयन के लिए दिशानिर्देश

(दूसरा पुनरीक्षण)

Methods for Statistical Quality Control During Production

Part 0 Guidelines for Selection of Control Charts

(Second Revision)

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Statistical Methods for Quality and Reliability Sectional Committee, MSD 03

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Statistical Methods for Quality and Reliability Sectional Committee, had been approved by the Management and Systems Division Council.

The control charts are extensively being used by the industry for controlling the quality during manufacturing. For this purpose, the Indian Standards describing various control charts to be used under different situations have been published as different parts of IS 397.

For wider application, a need was felt to provide the guidelines for selection of an appropriate control chart for a specific application. This standard has been brought out to fulfill that need and this standard has been made a part of this series. Apart from the field of application, the merits and demerits of each type of chart are discussed. The tabular presentation would enable the user to quickly select the relevant chart, to be used in a given situation.

This standard was originally issued in 1999 and subsequently revised in 2003. The revision of this standard has been undertaken to incorporate guidelines on control charts covered in the new or revised Indian Standards published subsequently.

This Indian Standard is published in several parts. The other parts in this series are:

Part 1	Control charts for variables (*second revision*)
Part 2	Control charts for attributes (*third revision)*
Part 3	Specialized control charts (Adoption of ISO 7870-5)
Part 4	Cumulative sum chart (Adoption of ISO 7870-4)
Part 5	Acceptance control charts (Adoption of ISO 7870-3)
Part 6	EWMA control charts (Adoption of ISO 7870-6)
Part 7	Multivariate control charts ((Adoption of ISO 7870-7)
Part 8	Charting techniques for short runs and small mixed batches (Adoption of ISO 7870-8)

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

Indian Standard

METHODS FOR STATISTICAL QUALITY CONTROL DURING PRODUCTION

PART 0 GUIDELINES FOR SELECTION OF CONTROL CHARTS

(Second Revision)

1 SCOPE

This Standard (Part 0) provides guidelines for selection and use of appropriate control chart(s) for controlling the processes during production. Merits and demerits of each type of control chart have also been given.

2 REFERENCES

The following standards contain provisions, which through reference in this text constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
397	Method for statistical quality control during production
Part 1 : 2003	Control charts for variables (*second revision*)
Part 2 : 2003	Control charts for attributes (*third revision)*
Part 3 : 2019	Specialized control charts (Adoption of ISO 7870-5)
Part 4 : 2018	Cumulative sum chart (Adoption of ISO 7870-4)
Part 5 : 2015	Acceptance control charts (Adoption of ISO 7870-3)
Part 6 : 2018	EWMA control charts (Adoption of ISO 7870-6)
Part 7 : 2020	Multivariate control charts
Part 8 : 2018	Charting techniques for short runs and small mixed batches (Adoption of ISO 7870-8)
7920	Statistical vocabulary and symbols
Part 1 : 2012	General statistical terms and terms used in probability (Modified ISO 3534-1)
Part 2 : 2012	Applied Statistics (Adoption of ISO 3534-2)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 7920 (Part 1) and IS 7920 (Part 2) shall apply.

4 TYPES OF CONTROL CHARTS AND THEIR APPLICABILITY

4.1 The guidelines for selection and use of appropriate control charts to control the process during production for variable type of data is given in Table 1.

4.2 The guidelines for selection and use of appropriate control charts to control the process during production for attribute type of data is given in Table 2.

Table 1 Types of Control Charts and their Applicability for Variable Type of Data

(*Clause* 4.1)

Sl No.	Type of Chart	General Field of Application	Merits	Demerits	Ref. to Indian Standard
(1)	(2)	(3)	(4)	(5)	(6)
i)	Average-Range Chart ($\overline{X} - R$)	Control of individual characteristic when sample results are available at small intervals and/or the product is not perfectly homogeneous	a) Maximizes information from available data b) Provides information on central value and variation for control c) Samples of small size suffices d) Convenient for shop-floor operators	a) Difficult to understand, training becomes necessary b) Less precise for assessment of variation for large sample size as Range may be affected by presence of extreme values.	**6.3.2.1** and **6.3.1.1** of IS 397 (Part 1)
ii)	Average-standard deviation chart ($\overline{X} - s$)	-do-	a) Same as $\overline{X} - R$ chart merits a) to d) above b) More precise for assessment of variation than $\overline{X} - R$ chart c) Applicable even for large sample sizes	a) Difficult to understand, training becomes necessary b) Requires more calculations than $\overline{X} - R$ chart	**6.3.2.1** and **6.3.1.2** of IS 397 (Part 1)
iii)	Median-range chart (Me – R)	-do-	a) Same as $\overline{X} - R$ chart b) Easy to adopt when sample size is odd and small c) More appropriate in certain situations for example non-normal distributions as median is not affected by extreme values	a) Not easy to use when sample size is large or even. b) Less efficient as compared to mean chart	**6.3.2.2** and **6.3.1.1** of IS 397 (Part 1)
iv)	Mid range - range chart ($\overline{M} - R$)	-do-	a) Same as $\overline{X} - R$ chart b) Calculation is simplified	a) Less efficient than mean chart	**6.3.2.3** and **6.3.1.1** of IS 397 (Part 1)
v)	X (Individual) chart	Control of individual characteristic when sample results are available at longer intervals or product is homogeneous	a) Simple to operate b) Specification limits can be super imposed on control chart	a) Short term variations not detectable b) It is assumed that individual characteristics follow normal distribution	**6.3.3** of IS **397** (Part 1)
vi)	Moving average and moving range chart	Control of individual characteristic when sample results are available at small intervals and/or the product is not perfectly homogeneous	a) Need not wait for accumulation of samples b) Provides an early warning signal c) It is more efficient than $\overline{X} - R$ chart	a) Successive points are not independent b) Traditional interpretation of runs is not valid	**6** of IS 397 (Part 3)
vii)	High-Low chart	When sample is large in size (greater than six) and sequence of production is irrelevant	a) Extremely simple since no calculation is required b) One chart instead of two charts	a) Not very useful when the process is erratic	**9** of IS 397 (Part 3)
viii)	Coefficient of variation chart (γ)	Relative variability in relation to mean is of concern	One chart instead of two	a) More calculations are involved	**11** of IS 397 (Part 3)

Table 1 *(Continued)*

Sl No.	Type of Chart	General Field of Application	Merits	Demerits	Ref. to Indian Standard
(1)	(2)	(3)	(4)	(5)	(6)
ix)	Trend	Control of individual characteristics when the process level is changing systematically	a) It minimizes the frequency of process adjustments resulting in corresponding cost reduction b) Calculations are simplified	a) Useful only when process capability index is very high b) Less efficient than mean chart c) No further assembly is involved	**10** of IS 397 (Part 3)
x)	Modified control	Control of individual characteristic when process capability index is high (preferably C_{pk} is more than 1.50)	a) May be used as adjustment chart if systematic trends or cyclic patterns exist	a) Not recommended when components are meant for assembly	**10** of IS 397 (Part 1)
xi)	Group control	Control of individual characteristic when samples are drawn from different sources having same averages and variability	a) Involves less work in plotting the chart b) Compact presentation makes it easier to interpret c) It is easier to identify sub-groups running consistently high or low	a) Needs experience and skill in interpretation	**8** of IS 397 (Part 3)
xii)	Cumulative sum (CUSUM)	Control of individual characteristic when it is desired to detect even the small shift in the process average	a) Particularly useful when detection of small changes which go undetected in usual charts and are yet vital	a) Needs training and more calculations	**4** and **5** of IS 397(Part 4)
xiii)	Z- Chart	Where processes are needed to be controlled when there are large varieties of products with different specifications, different variability, production runs are small with varying sample/lot sizes.	a) The z-chart has the advantage of simplified calculation, presentation and most important it facilitates usual interpretation of Shewhart control charts to control the processes and decision-making.	a) When there is no historical data, this chart may be difficult to apply because it requires past data for estimating variability.	**7** of IS 397 (Part 3)
xiv)	Non-Normal	Control of individual characteristic when samples are drawn from processes which exhibit non-normal behaviour,	a) Non-normal pattern is observed in many situations, like in service industry (Hospitals, BPOs, etc.), in Special processes (welding, chemical processes, etc). Therefore, this chart is useful in such situations	a) It requires large subgroups. b) It is difficult to understand c) It requires more calculations	**12** of IS 397 (Part 3)
xv)	Exponentially Weighted Moving Average (EWMA)	Control of individual characteristic when it is desired to detect small shifts in the process mean. It makes possible the faster detection of small to moderate shifts in the process average.	a) EWMA control charts is efficient in detecting small shift in the process average b) EWMA control chart is relatively robust in the face of non-normally distributed quality characteristics.	a) The EWMA control chart does not reflect the out of control situations for larger shifts as quickly as the Shewhart control chart does. b) As production proceeds, if a trend develops, the trend is unfortunately shown to be well within control of the EWMA chart's control limits.	**4** of IS 397 (Part6)

Table 1 *(Concluded)*

Sl No.	Type of Chart	General Field of Application	Merits	Demerits	Ref. to Indian Standard
(1)	(2)	(3)	(4)	(5)	(6)
xvi)	Acceptance Control Charts	This chart is used to take decisions in terms of process acceptance, that is, whether designated percentage of products produced or services derived from the process meet the specification limits, and whether process average has shifted beyond allowable shift in the process average	This chart introduces concept of process acceptance	This chart can be used only when: a) the within subgroup variation is in-control and the variation is estimated efficiently (at minimum cost); b) a high level of process capability has been achieved.	**6** of IS 397 (Part 5)
xvii)	Multivariate control charts	Multivariate charts are used to determine whether process is under control when number of inter dependent quality characteristics are to be controlled simultaneously.	This is useful when the characteristics of a product are highly correlated, and in such situations Shewhart control charts give misleading information.	Multivariate control charts work well when the number of process variables is not too large – say, ten or fewer. As the number of variables grows, however, traditional multivariate control charts lose efficiency with regard to shift detection.	**5**, **6** and **7** of IS 397 (Part 7)

Table 2 Types of Control Charts and their Applicability for Attribute Type of Data

(*Clause* 4.2)

Sl No. (1)	Type of Chart (2)	General Field of Application (3)	Merits (4)	Demerits (5)	Ref. to Indian Standard (6)
i)	Number of non-conforming Items *np Chart*	Control of overall fraction non-conforming items of a process	a) Data required are often already available from inspection records b) Easily understood c) Provides overall picture	a) Does not provide detailed information for control of individual characteristic b) Does not recognize criticality of non-conformity in products(s) c) Requires fixed sample size from each subgroup	**6.3.2** of IS 397 (Part 2)
ii)	Fraction non-conforming *P Chart* (proportion) or *P* (percent)	Control of overall proportion/percent non-conforming items of a process	a) Same as for *np* chart b) This chart is used when sample size (n) varies.	a) Does not provide detailed information for control of individual characteristic. b) Does not recognize criticality of non-conformity in products(s) c) Control limits vary with the sample size, and therefore, these limits will not be straight lines d) Requires more calculations as compared to *np* chart	**6.3.1** of IS 397 (Part 2)
iii)	Standardized '*p*' *Chart*	Control of overall fraction non-conforming of a process	a) Control limits and standard line are fixed b) Interpretation is facilitated	a) Involves more calculations	**13** of IS 397 (Part 3)
iv)	number of non-conformities chart *C Chart*	Control of overall number of non-conformities of a process	a) Index of non-conformities per unit is easily understandable b) Very simple and easy to understand	a) Does not provide detailed information for control of individual characteristics b) Not applicable when unequal number of items are being inspected from each subgroup	**6.3.3** of IS 397 (Part 2)
v)	number of non-conformities per item chart *u Chart*	Control of overall number of non-conformities per item of a process	Applicable in situations when sample size vary	a) Control limits depend on sample size and therefore, these limits will not be straight lines	**6.3.4** of IS 397 (Part 2)
vi)	Demerit control chart	Control of non-conformities with their criticality	a) In addition to advantages of c (or u-) chart, it takes into account the intensity, extent and seriousness of non-conformity b) Scoring system considers the extent and seriousness of non-conformities	a) Scoring system has to be worked out and its usages explained through a suitable training programme b) Involves more calculations	**14** of IS 397 (Part 3)

Table 2 (*Concluded*)

Sl No.	**Type of Chart**	**General Field of Application**	**Merits**	**Demerits**	**Ref. to Indian Standard**
(1)	(2)	(3)	(4)	(5)	(6)
vii)	Inspection by gauging	Control of individual characteristics, when instead of hitting the target it is essential to meet the specifications, as in assembly operations	a) Data on number of oversize and undersize items available b) Measurement of individual values is difficult, uneconomic or impossible but easy to know whether it is below or above a certain value X c) As substitute of `X – R chart, it requires larger sample size but still reduces overall inspection load d) It is more efficient than *p* chart	a) Requires training and conviction that narrow gauging will not be harsh in application since artificial level of acceptance is created consistent with quality requirements b) Pattern of data on individual characteristic is unknown	**15** of IS 397 (Part 3)
viii)	Short run Chart, small mixed batch control charting	To control product characteristics or process parameters regardless of the type of feature or differences in units of measure and process spread	a) It is simple to use b) The chart is accurate if the values of the quality characteristic conform to a normal distribution.	a) If the distribution is not normal, the test will only give an approximate guide.	**6** of IS 397 (Part 8)

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Statistical Methods for Quality and Reliability Sectional Committee, MSD 03

Organization	*Representative(s)*
Indian Statistical Institute, Kolkata	Prof Bimal K. Roy (***Chairman***)
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Bharat Electronics Ltd, Ghaziabad	Ms Smitha Purohit Mr Adarsh Anand (*Alternate*)
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Institute of Quality and Reliability, Pune	Shri Hemant Urdhawarshee Shri Yashwant Mahakal (*Alternate*)
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M/s Mahle Filter Systems India (P) Ltd,	Shri Asheesh Gaur
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National Productivity Council, New Delhi	Dr K. P. Sunny
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Tata Motors Ltd, Pune	Mrs Asmita A. Ghate Shri A. P. Srivastava (*Alternate*)
In personal capacity	Prof S. Chakraborty

Organization	*Representative(s)*
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Composition of Subcommitee for "Process Control" (MSD 3:5)

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